Two new species of Amblyseiinae Muma (Acari: Mesostigmata: Phytoseiidae) from southwest China

Authors: Fang , Xiao-Duan, Wu, Yu-Chun, and Wu , Wei-Nan

Source: Systematic and Applied Acarology, 24(4) : 572-580

Published By: Systematic and Applied Acarology Society

URL: https://doi.org/10.11158/saa.24.4.4

Systematic & Applied Acarology 24(4): 572–580 (2019) ISSN 1362-1971 (print)
http://doi.org/10.11158/saa.24.4.4 ISSN 2056-6069 (online)

Article http://zoobank.org/urn:lsid:zoobank.org:pub:1AAC6E09-133E-4B36-A105-F294F6E7A99E

Two new species of Amblyseiinae Muma (Acari: Mesostigmata: Phytoseiidae) from southwest China

XIAO-DUAN FANG [1], YU-CHUN WU[1] & WEI-NAN WU [1]*
[1] *Guangdong Key Laboratory of Animal Conservation and Resource Utilization, Guangdong Public Laboratory of Wild Animal Conservation and Utilization, Guangdong Institute of Applied Biological Resources, Guangzhou, Guangdong 510260, China.*
** Corresponding author. E-mail: wuweinangz@163.com*

Abstract

Amblyseiinae is the largest subfamily of Phytoseiidae with 196 recorded species from China. Two new species, *Amblyseius basaensis* **sp. nov.** and *Transeius guangheensis* **sp. nov.**, were found by examining the specimens collected from two southwest provinces in China, both near to Vietnam border. Herein, they are described and illustrated based on the female specimens.

Key words: *Amblyseius*, *Transeius*, taxonomy, description

Introduction

Phytoseiid mites (Acari: Phytoseiidae) are diverse and widespread arthropods, playing important ecological role, and some of them have been used widely for controlling phytophagous mites and small insects (Kostiainen & Hoy 1996; Wu *et al*. 2009; McMurtry *et al*. 2013). Amblyseiinae is the largest subfamily in the family Phytoseiidae, with 1816 nominal species in the world, included in 66 genera (Demite *et al.* 2019). So far 196 species belonging to 15 genera of phytoseiid mites have been recorded in China (Wu *et al.* 2009; Fang *et al.* 2017; Liao *et al.* 2017, 2018; Demite *et al.* 2019).

Guangxi Zhuang Autonomous Region and Yunnan Province are both located in southwest China, mountainously and inhabited by many ethnic minorities. Their geographical position are border on Vietnam, belonging to East Palaearctic (Cox 2001), among which, Guangxi is karst landform in most areas and Yunnan is relatively higher altitude, located in the Yunnan-Guizhou plateau. Currently, the phytoseiid species recorded in Guangxi and Yunnan is 52 and 57 species respectively. Among them 37 and 39 species belong to the subfamily Amblyseinae, respectively (Wu *et al.* 2010). This study presents two new species *Amblyseius basaensis* **sp. nov.** and *Transeius guangheensis* **sp. nov.** from the above two sites.

Materials and Methods

Mite specimens examined in this study were collected from Guangxi and Yunnan provinces during May to June in 2016, with a particular focus on the two southwest provinces in China, Guanghe Village, Zuozhou Town, Chongzuo City, Guangxi Zhuang Autonomous Region and Basa Village, Hekou Town, Honghe Hani and Yi Autonomous Prefecture, Yunnan Province. Mites were mounted in Hoyer's medium and examined, measured, illustrated, and photographed under an optical microscope (Leitz®512836) and picture pick-up system (NIS-Elements D 4.50.00 64-bit edition).

Measurements are presented in micrometers (μm). Holotype measurements are shown in bold type for the new species, followed by their mean and range in parentheses. Morphological features of adult mites were measured according to descriptions in Fang *et al.* (2018): dorsal shield length and width were taken from the anterior to posterior margins of the shield along the midline and from the lateral margins at *s4* level; for all ventral shields, lengths were measured along their midline from the anterior to posterior margins; widths were taken from the lateral margins at *st2, st5* and *ZV2* level respectively; cheliceral fixed digit length was measured from dorsal poroid to anterior tip and movable digit length measured from the basal articulation to the tip. The general terminology used for morphological descriptions in this study follows that of Chant & McMurtry (2007), idiosomal seta terminology follows those by Rowell *et al*. (1978) and Chant & Yoshida-Shaul (1991, 1992), adenotaxy and poroidotaxy terminology followed that of Beard (2001), and chaetotaxy of legs follows that of Evans (1963).

Taxonomy

Amblyseius basaensis Fang & Wu sp. nov.

(Figures 1–7)

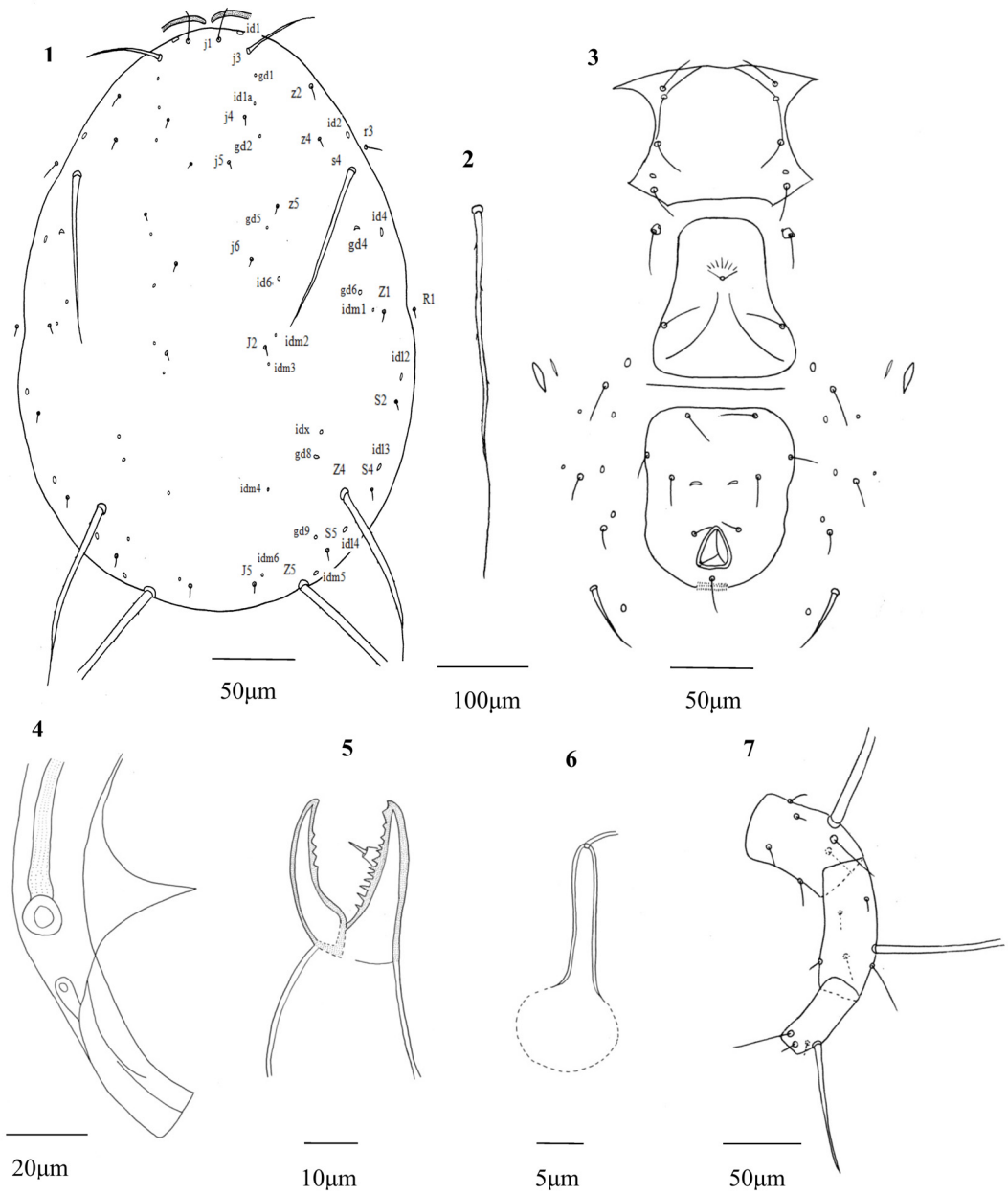
Diagnosis. Dorsal shield surface smooth. All dorsal shield setae smooth, except *Z4*, *Z5* long, whip-like, serrate. With seven pairs of solenostomes on dorsal shield (*gd1–gd2*, *gd4–gd6*, *gd8–gd9*). Sternal shield length longer than width, with three pairs of setae. One pair of solenostomes posteromedian to *JV2*. Peritreme extending anteriorly beyond *j1*. Fixed and movable digits of chelicera with 12 and four teeth, respectively. Calyx of spermatheca tubular, distal flaring, atrium small-knobbed, incorporated with calyx. Genu, tibia and basitarsus of leg IV each with a long and sharp-pointed macroseta. Genua of legs I–III each with one macroseta.

Female (n=8)

Dorsal idiosoma (Figures 1, 2). Dorsal setal pattern 10A: 9B. Dorsal shield smooth. Dorsal shield **323** 310 (299–323) long and **231** 196 (182–231) wide, distances between setae *j1–J5* **310** 296 (280–311) and *s4–s4* **175** 166 (157–175), shield nearly oval, very slightly constricted at level of *R1*. Setae *r3* and *R1* on soft membranous cuticle laterad dorsal shield, *r3* at level of *z4*, *R1* at level of shield incisions. All setae smooth, except *Z4* and *Z5* long, whip-like, serrate. With seven pairs of solenostomes (*gd1–gd2*, *gd4–gd6*, *gd8–gd9*), and 15 pairs of lyrifissures (*id1a*, *id1–id2*, *id4*, *id6*, *idx*, *idl2–idl4*, *idm1–idm6*) on dorsal shield. Length of setae: *j1* **24** 28 (24–30), *j3* **48** 48 (45–50), *j4* **5** 5 (3–5), *j5* **3** 4 (3–6), *j6* **5** 5 (5–7), *J2* **5** 6 (5–7), *J5* **7** 7 (5–8), *z2* **10** 10 (9–12), *z4* **7** 7 (6–9), *z5* **5** 4 (3–6), *Z1* **6** 7 (5–7), *Z4* **129** 119 (110–131), *Z5* **363** 344 (332–370), *s4* **119** 114 (110–120), *S2* **9** 8 (6–9), *S4* **8** 8 (7–10), *S5* **8** 8 (7–10), *r3* **12** 14 (11–15), *R1* **7** 7 (6–9).

Ventral idiosoma (Figure 3). Ventral setal pattern JV-3: ZV. All ventral setae smooth. Sternal shield smooth, anterior margin convex, posterior margin almost flat, **81** 77 (75–81) long, **74** 73 (70–76) wide, length longer than width, with three pairs of setae *st1* **33** 31 (29–34), *st2* **34** 29 (28–34), *st3* **28** 26 (24–28), and two pairs of lyrifissures (*pst1–pst2*), distance between *st1–st3* 62 61 (58–64) and *st2–st2* **67** 66 (64–69). Metasternal platelets drop-shaped, each with one metasternal seta, *st4* **24** 24 (22–26) and one lyrifissure (*pst3*). Genital shield smooth, width at level of genital setae (*st5*) **69** 67 (65–69), with one pair of thin genital setae *st5* **20** 22 (19–23), trailing edge flat; one pair of associated poroids on soft cuticle near posterior corners of shield. Ventrianal shield smooth, sub-rectangular, **114** 107 (105–114) long, **83** 78 (76–83) wide at level of *ZV2*, with three pairs of thin pre-anal setae *JV1* **18** 18 (17–21), *JV2* **19** 18 (15–19), *ZV2* **17** 15 (14–17); *Pa* **19** 17 (15–20), *Pst* **19**

16 (14–19) long. Pre-anal pores crescent-shaped, posteromedian to *JV2*, distance between pores **21** 20(19–21). Opisthogastric soft cuticle with four pairs of setae, *ZV1* **12** 14 (12–16), *ZV3* **9** 8 (7–10), *JV4* **7** 8 (7–10), *JV5* **86** 83 (80–88) long. All ventral setae thin, except *JV5*, thicker. Two pairs of metapodal platelets, primary platelets **27** 22 (20–27) long, **7** 6 (5–7) wide, secondary ones **11** 11 (9–12) long, **2** 3 (2–3) wide.



FIGURES 1–7. ***Amblyseius basaensis*** **sp. nov.**, female. 1. Dorsal shield; 2. *Z5*; 3. Ventral idiosoma; 4. Posterior region of peritrematal shield; 5. Chelicera; 6. Spermatheca; 7. Leg IV, genu-basitarsus. Scale bars: 100 µm for 2; 50 µm for 1, 3, 7; 20 µm for 4; 10 µm for 5; 5 µm for 6.

TABLE 1. Differences in diagnostic characters between *Amblyseius basaensis* Fang & Wu **sp. nov.** and similar species.

	basaensis[a]	*cessator*[b]	*tamatavensis*[c,d]	*supercaudatus*[e]	*longisaccatus*[f]
Dorsal setae	*Z5*≈3*Z4*, *Z5*≈3*s4*	*Z5*≈1.5*Z4*, *Z5*≈2*s4*	*Z5*≈2*Z4*, *Z5*≈2.5*s4*	*Z5*≈2*Z4*, *Z5*≈2.5*s4*	*Z5*≈2.5*Z4*, *Z5*≈3*s4*
Posterior margin of sternal shield	straight	straight	straight	concave	straight
Ventrianal shield	sub-rectangular (length > width)	quadrate	sub-rectangular (length < width)	sub-rectangular (length > width)	pentagonal
No. of teeth on FD/MD	12/4	11-13/3	11/4	10/1	14/4
Spermatheca	calyx tubular, flaring distally, atrium incorporated with calyx, major duct narrower than calyx	calyx tubular-fundibular, atrium directly connected with base of calyx, major duct as wide as calyx	calyx tubular, flaring distally, atrium incorporated with calyx, major duct as wide as calyx	calyx tubular, flaring distally, atrium incorporated with calyx, major duct narrower than calyx	calyx long saccular, atrium directly connected with base of calyx, major duct narrower than calyx
Constriction at level of *R1*	with constriction	with constriction	with constriction	without constriction	with constriction
Pre-anal pore	crescent-shaped, posteromedian to *JV2*	round-shaped, posterior to *JV2*	crescent-shaped, posteromedian to *JV2*	crescent-shaped, behind and slightly mediad *JV2*	crescent-shaped, mesad *JV2*, almost in a line with *JV2*

[a] from eight specimens, [b] from De Leon, 1962, [c] from Blommers, 1974, [d] from Döker *et al.*, 2018, [e] from Karg, 1994, [f] from Wu *et al.*, 2009

Peritreme. Peritreme extending anteriorly beyond *j1*. Posterior margin of peritrematal shields truncate (Figure 4)

Chelicera (Figure 5). Fixed digit **29** 29 (27–31) long, with 12 teeth and *pilus dentilis*, movable digit **33** 32 (31–34) long, with four teeth.

Spermatheca (Figure 6). Calyx of spermatheca **15** 15 (14–17) long, **3** 3 (3–3) wide at middle region, tubular, distal flaring; atrium **2** 2 (1–2) wide, small, knobbed, incorporated with calyx; major duct narrow, very short, directly attached to calyx, without neck, and minor duct invisible.

Legs. Genua formula for leg I 2-2/2, 2/1-1, leg II 1-2/1, 2/0-1, leg III 2-2/0, 1/1-1, leg IV 2-1/1, 2/0-1. Genua I–III each with one macroseta, *Sge* I **57** 54 (52–58), *Sge* II **36** 38 (35–40), *Sge* III **72** 70 (68–74). Leg III with one macroseta on tibia, *Sti* III **57** 55 (52–59). Leg IV with three long, whip-like macrosetae on genu, tibia and basitarsus (Figure 7), *Sge* IV **153** 154 (149–158), *Sti* IV **105** 108 (101–110) and *St* IV **74** 76 (70–78), *Sge* IV > *Sti* IV> *St* IV.

Male. Unknown

Material examined. Holotype: ♀, Basa Village, Hekou Town, Hekou Yao Autonomous County, Honghe Hani and Yi Autonomous Prefecture, Yunnan Province (accession no. YN-0204), *Ageratum conyzoides* L. May 25, 2016, Fang X.D. coll. Paratypes: 7♀ (accession no. YN-0021, YN-0041, YN-0191, YN-0192, YN-0201, YN-0632, YN-0642), same locality, host, date and collector as holotype.

Etymology. The name *basaensis* refers to the type locality Basa Village, where the type specimens were collected.

Remarks. Due to the spermatheca with length/width of calyx at mid-point > 3.4: 1.0, this species belongs to the *aerilalis* or *nicola* species subgroups (Chant & McMurtry 2004). By having similar shape of dorsal shield, smooth quadrangular ventrianal shield, elongated spermatheca and presence of a macroseta on genu, tibia and basitarsus of leg IV (*Sge* IV > *Sti* IV> *St* IV), *A. basaensis* **sp. nov.** is similar to *A. cessator* De Leon, 1962, *A. tamatavensis* Blommers, 1974 and *A. longisaccatus* Wu, Lan & Liu, 1995. By having similar shape of ventrianal shield and spermatheca, the new species is

similar to *A. supercaudatus* Karg, 1994. Differences between *A. basaensis* **sp. nov.** and the related species are given in Table 1.

***Transeius guangheensis* Fang & Wu sp. nov.**
(Figures 8–13)

Diagnosis. Dorsal shield surface mostly smooth, with anterolateral reticulation. All dorsal shield setae smooth, except *Z4*, *Z5* thick, serrate. With seven pairs of solenostomes on dorsal shield (*gd1–gd2*, *gd4–gd6*, *gd8–gd9*). Sternal shield length and width similar, with three pairs of setae. One pair of solenostomes mesad *JV2*, almost in a line with setae *JV2*. Peritreme extending to *j1* level. Fixed and movable digits of ch–elicera with nine and three teeth, respectively. Calyx of spermatheca bell-shaped, atrium small-knobbed, incorporated with calyx. Genu, tibia and basitarsus of leg IV each with a macroseta. Genua of legs I–III each with one macroseta.

Female (n=7)

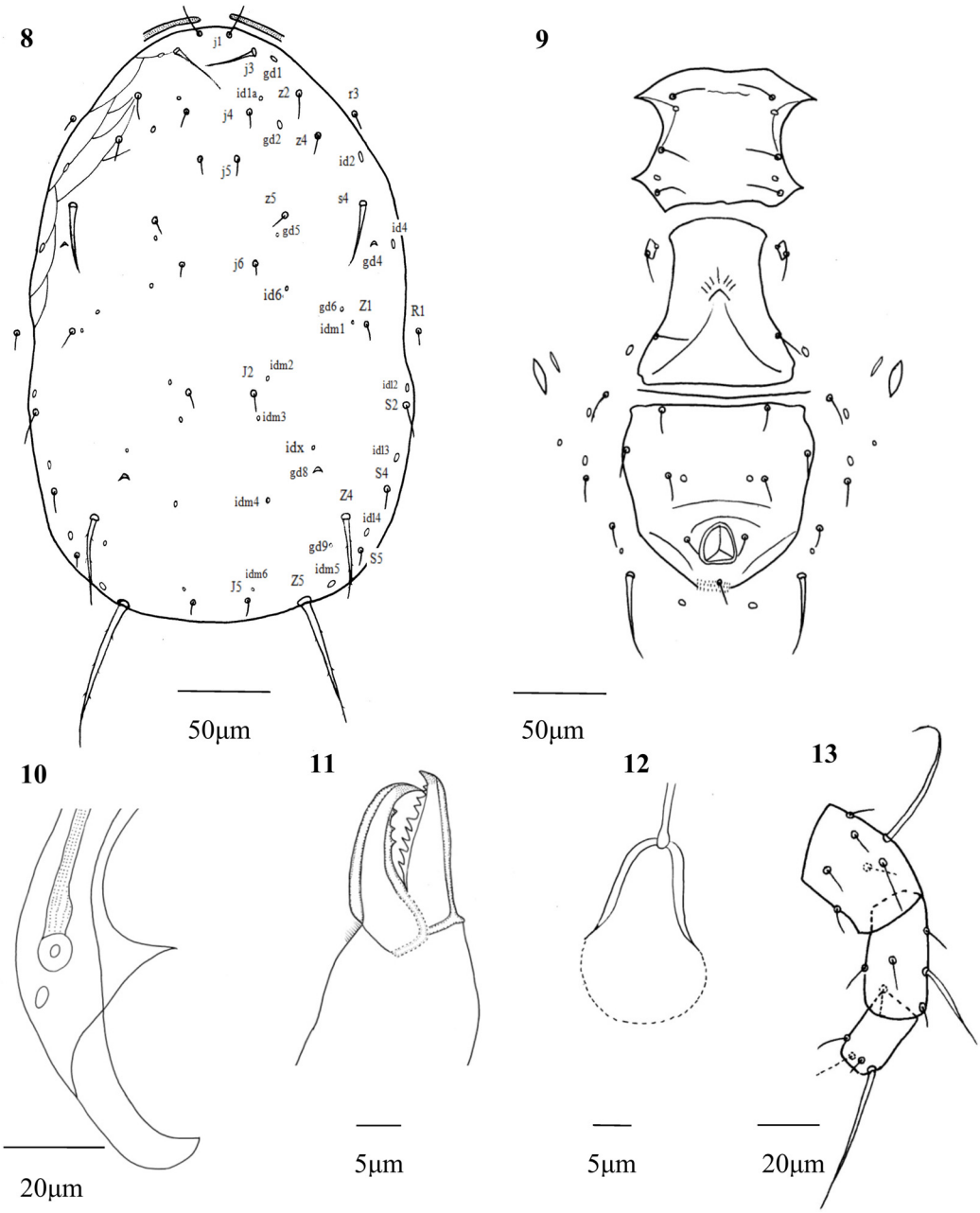
Dorsal idiosoma (Figure 8). Dorsal setal pattern 10A?9B. Dorsal shield **300** 296 (289–303) long and **179** 182 (172–193) wide, distances between setae *j1–J5* **292** 284 (275–292) and *s4–s4* **151** 151 (150–155), shield nearly oval, slightly constricted at level of *R1*; shield surface mostly smooth, with anterolateral reticulation, *r3* and *R1* on soft membranous cuticle laterad dorsal shield, *r3* at level of *z4*, *R1* at level of shield incisions. Dorsal setae *j1*, *j3*, *s4*, *Z4* and *Z5* relatively longer (> 15), other setae shorter. All dorsal shield setae smooth and setiform, except *Z4*, *Z5* thick, serrate. With seven pairs of solenostomes on dorsal shield (*gd1–gd2*, *gd4–gd6*, *gd8–gd9*), and 14 pairs of lyrifissures (*id1a*, *id2*, *id4*, *id6*, *idx*, *idl2–idl4, idm1–idm6*) on dorsal shield. Length of setae: *j1* **15** 18 (15–20), *j3* **24** 22 (20–25), *j4* **7** 7 (5–9), *j5* **7** 7 (5–9), *j6* **7** 7 (5–9), *J2* **10** 9 (7–10), *J5* **7** 7 (5–7), *z2* **13** 12 (11–14), *z4* **10** 10 (10–12), *z5* **7** 7 (5–8), *Z1* **8** 9 (7–10), *Z4* **39** 37 (35–40), *Z5* **72** 70 (69–74), *s4* **25** 27 (24–28), *S2* **13** 13 (11–15), *S4* **9** 10 (7–10), *S5* **8** 8 (7–9), *r3* **7** 8 (7–9), *R1* **8** 8 (7–10).

Ventral idiosoma (Figure 9). Ventral setal pattern JV-3: ZV. All ventral setae smooth. Sternal shield smooth, anterior margin convex, posterior margin of shield almost flat, **58** 57 (55–60) long, **65** 64 (63–67) wide, width longer than length, with three pairs of setae *st1* **20** 20 (17–22), *st2* 15 18 (14–19), *st3* **15** 17 (14–18), and two pairs of lyrifissures (*pst1–pst2*), distance between *st1–st3* **52** 51 (47–52) and *st2–st2* **58** 57 (56–58). Metasternal platelets drop-shaped, each with one metasternal seta, *st4* **15** 17 (14–18) and one lyrifissure (*pst3*). Genital shield smooth, width at level of genital setae (*st5*) **58** 62 (58–63), with one pair of thin genital setae *st5* **17** 17 (15–19), trailing edge flat; one pair of associated poroids on soft cuticle near posterior corners of shield. Ventrianal shield lightly striate, pentagonal, **100** 99 (95–102) long, **89** 88 (86–91) wide at level of *ZV2*, with three pairs of thin pre-anal setae *JV1* **14** 15 (14–17), *JV2* **13** 14 (12–15), *ZV2* **15** 14 (14–17); *Pa* **11** 13 (10–14), *Pst* **14** 12 (10–14) long. Pre-anal pores round-shaped, mesad *JV2*, almost in a line with setae *JV2*, distance between pores **33** 31 (29–33). Opisthogastric soft cuticle with four pairs of setae, *ZV1* **12** 14 (12–16), *ZV3* **10** 10 (9–12), *JV4* **9** 9 (7–11), *JV5* **33** 33 (29–35) long. All ventral setae thin, except *JV5*, thick. Two pairs of metapodal platelets, primary ones **17** 16 (14–17) long, **5** 5 (4–6) wide, secondary ones **10** 10 (10–12) long, **2** 2 (2–3) wide.

Peritreme. Peritreme extending to *j1* level. Peritrematal shields with posterior termination curved at tip (Figure 10).

Chelicera (Figure 11). Fixed digit **18** 19 (17–21) long, with nine teeth, *pilus dentilis* not visible; movable digit **23** 21 (19–24) long, with three teeth.

Spermatheca (Figure 12). Calyx of spermatheca **11** 10 (9–13) long, **7** 7 (5–7) wide at middle region, bell-shaped; atrium **2** 2 (2–2) wide, small, knobbed, incorporated with calyx; major duct narrow, without neck, and minor duct not visible.



FIGURES 8–13. *Transeius guangheensis* sp. nov., female. 8. Dorsal shield; 9. Ventral idiosoma; 10. Posterior region of peritrematal shield; 11. Chelicera; 12. Spermatheca; 13. Leg IV, genu-basitarsus. Scale bars: 50 μm for 8, 9; 20 μm for 10, 13; 5 μm for 11, 12.

Legs. Genua formula for leg I 2-2/2, 2/1-1, leg II 1-2/1, 2/1-1, leg III 1-2/2, 1/1-1, leg IV 2-1/1, 2/0-1. Genua of legs I–III each with one macroseta, *Sge* I **25** 25 (23–27), *Sge* II **19** 21 (18–23), *Sge*

III **24** 26 (23–27). Leg III with one macroseta on tibia, *Sti* III **20** 21(18–23). Genu, tibia and basitarsus IV each with one macroseta (Figure 13), *Sge* IV **47** 47 (45–50), *Sti* IV **31** 32 (29–33) and *St* IV **48** 48 (45–50), *St* IV ≈ *Sge* IV > *Sti* IV.

Male. Unknown.

Material examined. Holotype: ♀, Guanghe Village, Zuozhou Town, Jiangzhou Distrct, Chongzuo City, Guangxi Zhuang Autonomous Region (accession no. GX-0591), on *Phyllostachys bambusoides* Sieb. et Zucc. June 6, 2016, Fang X.D. coll. Paratypes: 6♀ (accession no. GX-0541, GX-0592, GX-0593, GX-0594, GX-0601), same locality, host, date and collector as holotype; Paratypes: 1♀ (accession no. GX-0661), *Cleome gynandra* L., same locality, date and collector as holotype.

Etymology. The name *guangheensis* refers to the type locality Guanghe Village, where the type specimens were collected.

Remarks. This new species belonging to *bellottii* species group and *bellottii* species sub-group by having bell-shaped calyx of spermatheca and short *z4* (Chant & McMurtry 2004).

By having very similar shape of dorsal shield, straight posterior margin of sternal shield, pentagonal ventrianal shield; similar shape of calyx of spermatheca and one macroseta on genu, tibia and basitarsus of leg IV, *T. guangheensis* **sp. nov.** is similar to *T. volgini* (Wainstein & Begljarov, 1971), T. fulvus Ehara & Toyoshima, 2006 and *T. jujae* El-Banhawy & Knapp, 2011. Differences between *T. guangheensis* **sp. nov.** and the related species are given in Table 2.

TABLE 2. Differences in diagnostic characters between *Transeius guangheensis* Fang & Wu **sp. nov.** and similar species.

	guangheensis[g]	*volgini*[h]	*fulvus*[i]	*jujae*[j]
Body size	289–303 long, 172–193 wide	400 long, 230 wide	405–409long, 250–260 wide	350 long, 195 wide
Dorsal shield	reticulate anterolaterally only	entirely smooth	striate laterally throughout	entirely smooth
Dorsal setae	*Z5*≈2*Z4*, *Z5*≈2.5*s4* *Z4, Z5* both serrate	*Z5*≈1.5*Z4*, *Z5*≈2.5*s4*	*Z5*≈1.5*Z4*, *Z5*≈2*s4* *Z4*smooth, *Z5* serrate	*Z5*≈1.5*Z4*, *Z5*≈1.5*s4* *Z4, Z5* both serrate
Anterior margin of genital shield	sclerotization normal	sclerotization normal	sclerotization weak	sclerotization weak
Ventrianal shield	striate at lower part, with small project in upper corners, upper broad and lower narrow, lateral margins straight	smooth, upper width close to lower, lateral margins concave	smooth, upper width close to lower, lateral margins concave	smooth, upper broad and lower narrow, lateral margins concave
Spermatheca	calyx bell-shaped, atrium incorporated with calyx	calyx bell-shaped, atrium directly connected with base of calyx	calyx bell-shaped, atrium directly connected with base of calyx	calyx saccular, atrium directly connected with base of calyx
Pre-anal pore	round-shaped, mesad *JV2*, almost in a line with *JV2*	round-shaped, behind and slightly mediad *JV2*	crescent-shaped, posterior to *JV2*	round-shaped, behind and slightly mediad *JV2*
Macrosetae	*St* IV ≈ *Sge* IV > *Sti* IV	*St* IV ≈ *Sge* IV > *Sti* IV	*St* IV > *Sge* IV > *Sti* IV	*St* IV > *Sge* IV > *Sti* IV

[g] from seven specimens, [h] from Wainstein & Begljarov, 1971, [i] from Ehara & Toyoshima, 2006, [j] from El-Banhawy & Knapp, 2011

Acknowledgement

We are grateful to Dr Jhih-Rong Liao (National Taiwan University) and all reviewers for revision of the manuscript. This paper was supported by the National Natural Science Foundation of China (31572013), GDAS Special Project of Science and Technology Development (2017GDASCX-0107) and GDAS Special Project of Science and Technology Development (2018GDASCX-0107).

References

Beard, J.J. (2001) A review of Australian *Neoseiulus* Hughes and *Typhlodromips* de Leon (Acari: Phytoseiidae: Amblyseiinae). *Invertebrate Taxonomy*, 15, 73–158. https://doi.org/10.1071/IT99017

Blommers, L. (1974) Species of the genus *Amblyseius* Berlese, 1914 from Tamatave East Madagascar (Acarina: Phytoseiidae). *Bulletin Zoologisch Museum Universiteit Amsterdam*, 3(19), 143–155.

Chant, D.A. & Yoshida-Shaul, E. (1991) Adult ventral setal patterns in the family Phytoseiidae (Acari: Gama sina). *International Journal of Acarology*, 17, 187–199. https://doi.org/10.1080/01647959108683906

Chant, D.A. & Yoshida-Shaul, E. (1992) Adult idiosomal setal patterns in the family Phytoseiidae (Acari: Gamasina). *International Journal of Acarology*, 18, 177–193. https://doi.org/10.1080/01647959208683949

Chant, D.A. & McMurtry, J.A. (2004) A review of the subfamily Amblyseiinae Muma (Acari: Phytoseiidae): Part III. The tribe Amblyseiini Wainstein, subtribe Amblyseiina n. subtribe. *International Journal of Acarology*, 30(3), 171–228. https://doi.org/10.1080/01647950408684388

Chant, D.A. & McMurtry, J.A. (2007) *Illustrated Keys and Diagnoses for the Genera and Subgenera of the Phytoseiidae of the World (Acari: Mesostigmata)*. West Bloomfield, USA, Indira Publication House, 220 pp.

Cox, B. (2001) The biogeographic regions reconsidered. *Journal of Biogeography*, 28, 511–523. https://doi.org/10.1046/j.1365-2699.2001.00566.x

Demite, P.R., Moraes, G.J., McMurtry, J.A., Denmark, H.A. & Castilho, R.C. (2019) Phytoseiidae Database. Available from: www.lea.esalq.usp.br/phytoseiidae/ (Access Feb 23 2019)

De Leon, D. (1962) Twenty-three new phytoseiids, mostly from southeastern united states (Acarina: Phytoseiida). *Florida Entomologist*, 45(1), 11–27.

Döker, İ., Hernandez, Y.V., Mannion, C. & Carrillo, D. (2018) First report of *Amblyseius tamatavensis* (Acari: Phytoseiidae) in the United States of America. *International Journal of Acarology*, 44, 101–104. http://dx.doi.org/10.1080/01647954.2018.1461132

Ehara, S., Toyoshima, S. & Amano, H. (2006) Three new species of Phytoseiid mites (Acari: Phytoseiidae) from Japan. *International Journal of Acarology*, 32(4), 345–350. http://dx.doi.org/10.1080/01647950608684480

El-Banhawy, E.M. & Knapp, M. (2011) Mites of the family Phytoseiidae Berlese from Kenya (Acari: Mesostigmata). *Zootaxa*, 2945, 1–176.

Evans, G.O. (1963) Observations on the chaetotaxy of the legs in the free-living Gamasina (Acari: Mesostigmata). *Bulletin of British Museum (Natural History) Zoology*, 10, 277–303. https://doi.org/10.5962/bhl.part.20528

Fang, X.D. & Wu, W.N. (2017) A new species of the genus *Neoseiulus* Hughes (Acari: Phytoseiidae) and the male of *Amblyseius ishizuchiensis* Ehara, 1972 from China. *Systematic and Applied Acarology*, 22, 1574–1584. http://doi.org/10.11158/saa.22.10.3

Fang, X.D., Hao, H.H. & Wu, W.N. (2018) Two new species of *Typhlodromus* Scheuten (Acari: Phytoseiidae) from Hainan Islands, China. *Systematic and Applied Acarology*, 23(5), 925–934. http://doi.org/10.11158/saa.23.5.10

Karg, W. (1994) Raubmilben der Cohors Gamasina Leach (Acarina, Parasitiformes) vom Galapagos-Archipel, Predatory mites of the cohors Gamasina Leach (Acarina, Parasitiformes) in the Galapagos Archipelago. *Mitteilungen aus dem Zoologischen Museum in Berlin*, 70(2), 179–216. https://doi.org/10.1002/mmnz.19940700202

Kostiainen, T.S. & Hoy, M.A. (1996) *The Phytoseiidae as biological control agents of pest mites and insects.* A bibliography (1960–1994). Monography 17, University of Florida, Agricultural Experiment Station, 355 pp.

Liao, J.R., Ho, C.C. & Ko, C.C. (2017) Species of the genus *Euseius* Wainstein (Acari: Phytoseiidae: Ambly-

seiinae) from Taiwan. *Zootaxa*, 4226(2), 205–228.
https://doi.org/10.11646/zootaxa.4226.2.3
Liao, J.R., Ho, C.C., Fang, X.D. & Ko, C.C. (2018) Contribution to the knowledge of the genera *Euseius* Wainstein and *Gynaseius* Wainstein (Acari: Mesostigmata: Amblyseiinae) from Taiwan. *Systematic & Applied Acarology,* 23(11), 2192–2213.
http://doi.org/10.11158/saa.23.11.12
McMurtry, J.A., De Moraes, G.J. & Sourassou, N.F. (2013) Revision of the lifestyles of phytoseiid mites (Acari: Phytoseiidae) and implications for biological control strategies. *Systematic and Applied Acarology*, 18, 297–320.
https://doi.org/10.11158/saa.18.4.1
Rowell, H.J., Chant, D.A. & Hansell, R.I.C. (1978) Determination of setal homologies and setal patterns on dorsal shield in family Phytoseiidae (Acarina: Mesostigmata). *The Canadian Entomologists*, 110, 859–876.
Wu, W.N., Lan, W.M. & Liu, Y.H. (1995) Four new species of phytoseiid mite (Acari: Phytoseiidae). *Acta Zooltaxonomica Sinica*, 20(3), 299–305 [in Chinese].
Wu, W.N., Ou, J.F. & Huang, J.L. (2009) *Fauna Sinica, Invertebrata Vol. 47, Arachnida, Acari, Phytoseiidae.* Beijing, Science Press, 511 pp. [in Chinese].
Wu, W.N., Liang, L.N., Fang, X.D. & Ou, J.F. (2010) Phytoseiidae (Acari: Mesostigmata) of China: A review of progress, with a checklist. *Zoosymposia*, 4, 288–315.
Wainstein, B.A. & Begljarov, G.A. (1971) New species of *Amblyseius* (Parasitiformes, Phytoseiidae) from the Primorsky Territory. *Zoologicheskii Zhurnal*, 50(12), 1803–1812 [in Russian].

Submitted: 11 Jan. 2019; accepted by Shahrooz Kazemi: 28 Mar. 2019; published: 12 Apr. 2019